



What do I have to do  
with chemistry?

# The Mole



Nothing, you dope! The Mole in Chemistry is a COUNTING UNIT! It was named in honor of Amedeo Avogadro, who discovered that no matter what type of gas there was, there was always the same number of MOLEcules present in the same volume.

The Mole is equal to:

$$6.02 \times 10^{23}$$

(Just like a dozen = 12)





So if a mole eats a dozen ants, he eats 12 ants. If a mole eats a mole of ants, he eats  $6.02 \times 10^{23}$  ants! A mole eating a mole of ants would be a FAT mole!

A mole of particles =  $6.02 \times 10^{23}$  particles

1 mole C =  $6.02 \times 10^{23}$  C atoms

1 mole  $\text{H}_2\text{O}$  =  $6.02 \times 10^{23}$   $\text{H}_2\text{O}$  molecules

1 mole NaCl =  $6.02 \times 10^{23}$  formula units of NaCl



Yeah, like somebody I know...







How big is a mole, anyway?



# A mole of Milk Bones...





Brainstorm for a mole analogy.

Then calculate exactly how big your analogy is.



# Representative units for moles....



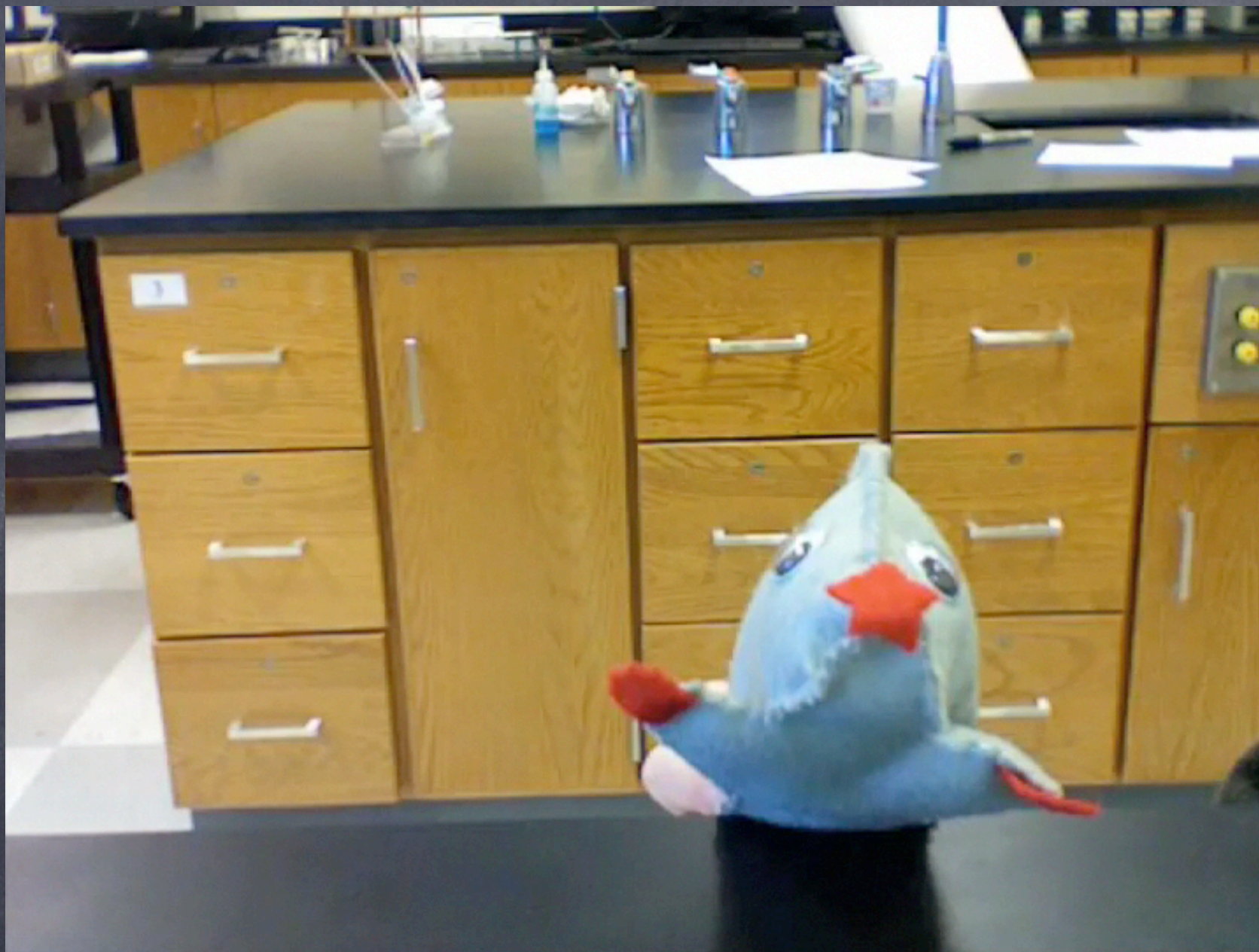
Element:

Atom

Cu

1 mole =  
 $6.02 \times 10^{23}$  atoms





Ionic  
compound:

formula unit



1 mole =  
 $6.02 \times 10^{23}$   
formula units

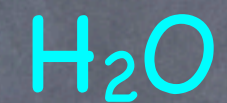
Remember, an ionic compound is made of a metal  
+ a nonmetal.





Molecular  
compound:

molecule

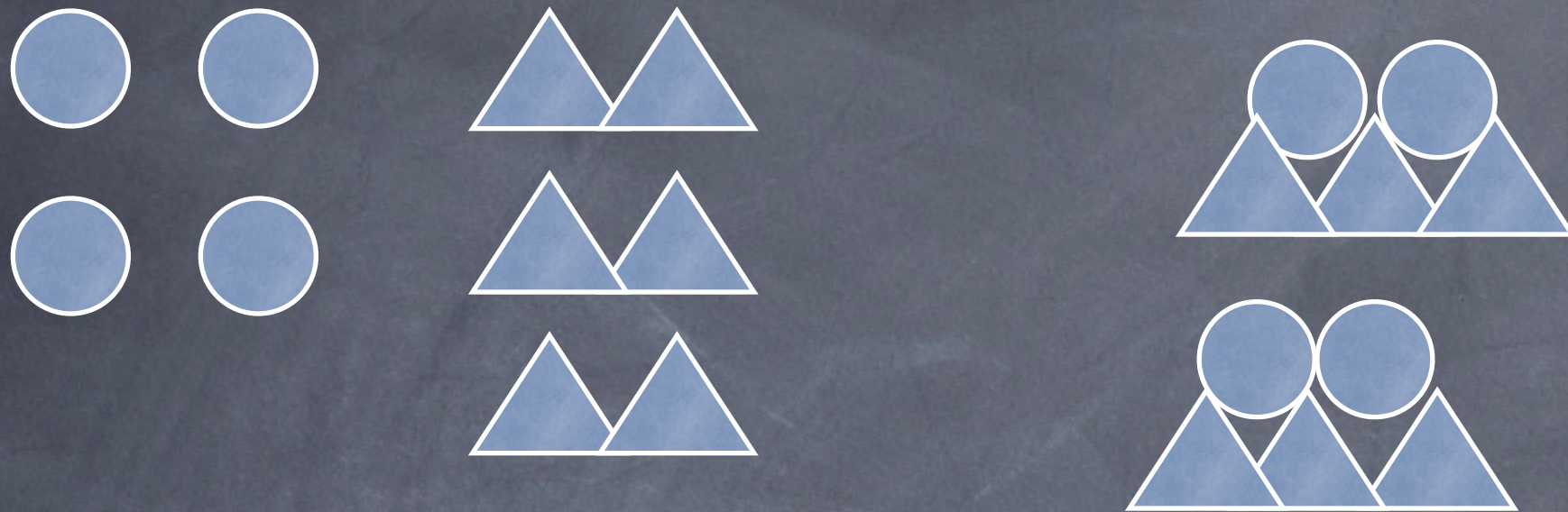


1 mole =  
 $6.02 \times 10^{23}$   
molecules

Remember, a molecular compound is composed of  
all nonmetals.



"4 moles of aluminum atoms + 3 moles of oxygen molecules yields 2 moles of aluminum oxide formula units.



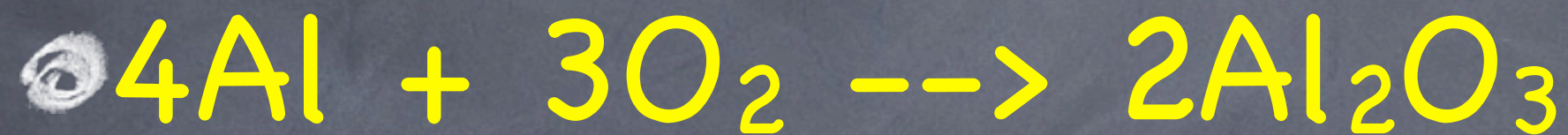
moles of  
substance

molar mass

moles of elements

atoms of  
elements





- This equation says: "4 moles of Al + 3 moles of  $\text{O}_2$  yields 2 moles of  $\text{Al}_2\text{O}_3$ "
- If one mole =  $6.02 \times 10^{23}$  atoms, then I have a lot of counting to do, right?



# How big is a mole?

## Another analogy:

- If you count to  $6.02 \times 10^{23}$ , one number per second, how long will it take?
- $6.02 \times 10^{23} \times 1\text{min}/60\text{sec} \times 1\text{hr}/60\text{min} \times 1\text{day}/24\text{hr} \times 1\text{yr}/365\text{days} =$
- $1.9 \times 10^{16}$  years = 19 quadrillion years!
- The earth is 4.6 billion years old, so that's 4 million times the earth's age!



Can we really count that many atoms????

Well, let's see.....





Counting to a mole.....



Mass of 1 mole = Atomic mass in  
grams.

So, we can count moles BY  
MEASURING MASS!

Moles are the link between counting atoms and  
molecules and mass.

# representative particles  MOLES  mass

The atomic mass in grams of any element is equal  
to one mole (or  $6.02 \times 10^{23}$  atoms) of that  
element!



# How to find moles....

- The mass of 1 mole of any element is equal to the atomic mass of that element in grams.
- So, 1 mole of Al = 27.0 grams.
- And 4 moles of Al =  $(4 \times 27.0) = 108$  grams.



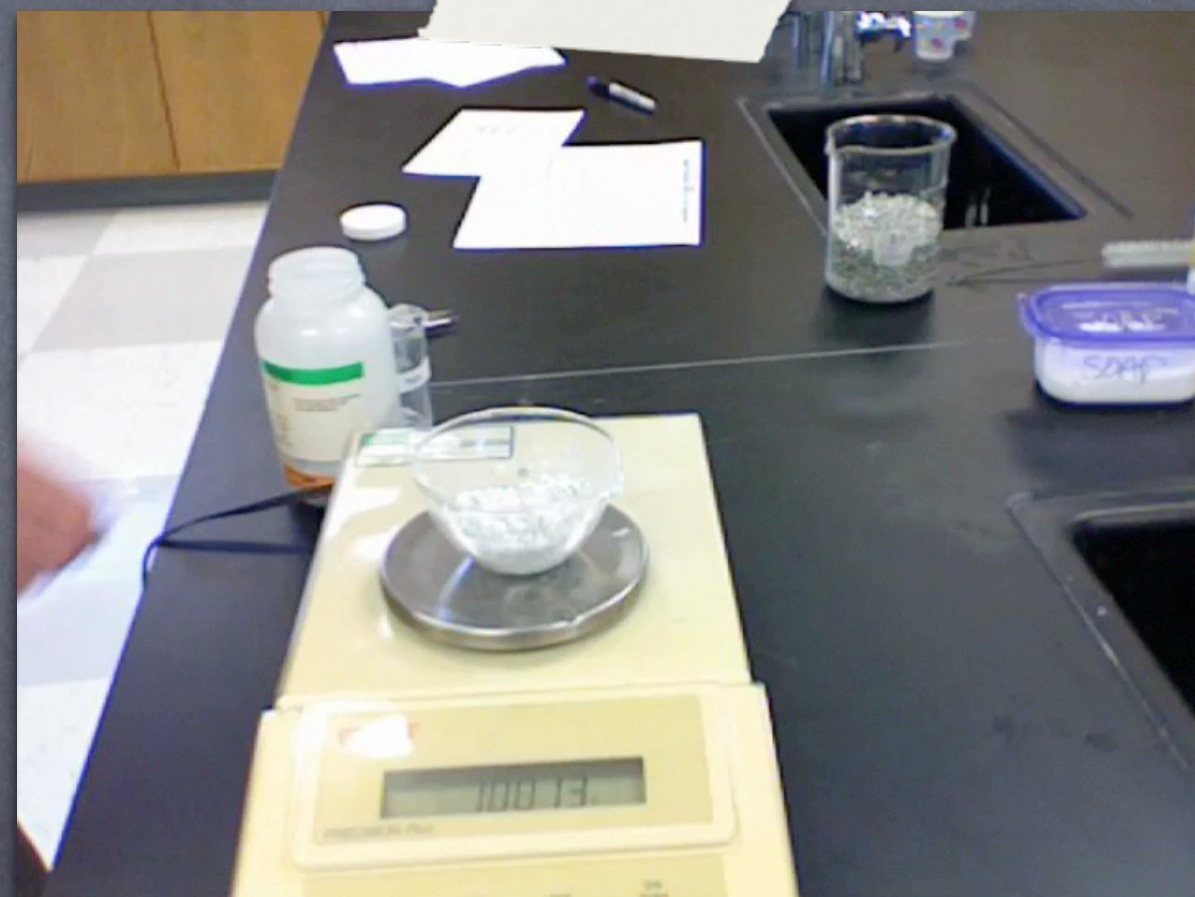


What about 1 mole  
of  $\text{CaCO}_3$ ?

That equals:

$$\begin{aligned} & 1 \text{ mole of Ca} = 40.1 \text{ g} \\ & + 1 \text{ mole of C} = 12.0 \text{ g} \\ & + 3 \text{ moles of O} = (16.0 \times 3) \text{ g} \\ & \qquad \qquad \qquad = 48.0 \text{ g} \end{aligned}$$

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# ALUMINUM

1 Mole =

$6.02 \times 10^{23}$



27.0 g





1 Mole =  
 $6.02 \times 10^{23}$   
formula units



100.1 g





Mole joke



# Molar Mass

• Find the mass of 1 mole of:

• Fe

• Ti

• SO<sub>2</sub>

• H<sub>2</sub>O



Find the molar mass of:

1 mole of  $O_2$

1 mole of  $ZnCl_2$

1 mole of  $PbSO_4$



## Practice with molar mass



Find the molar mass of:





# Conversion factors

Converting # of atoms to moles:

1 mol element  unit converting to  
 $6.02 \times 10^{23}$  atoms  unit converting from

How many moles is  $2.80 \times 10^{24}$  atoms of Si?

How many moles is  $2.17 \times 10^{23}$  atoms of Br?



Remember, a conversion factor is a fraction:

Units converting to -->

Units we want

Units converting from ---->

Units we want to get rid of





# Converting moles to # of atoms

Conversion is: moles  $\rightarrow$  molecules  $\rightarrow$  atoms



$6.02 \times 10^{23}$  molecules  
1 mol



# atoms in molecule  
1 molecule

How many atoms are in 1.14 mol  $\text{SO}_2$ ?

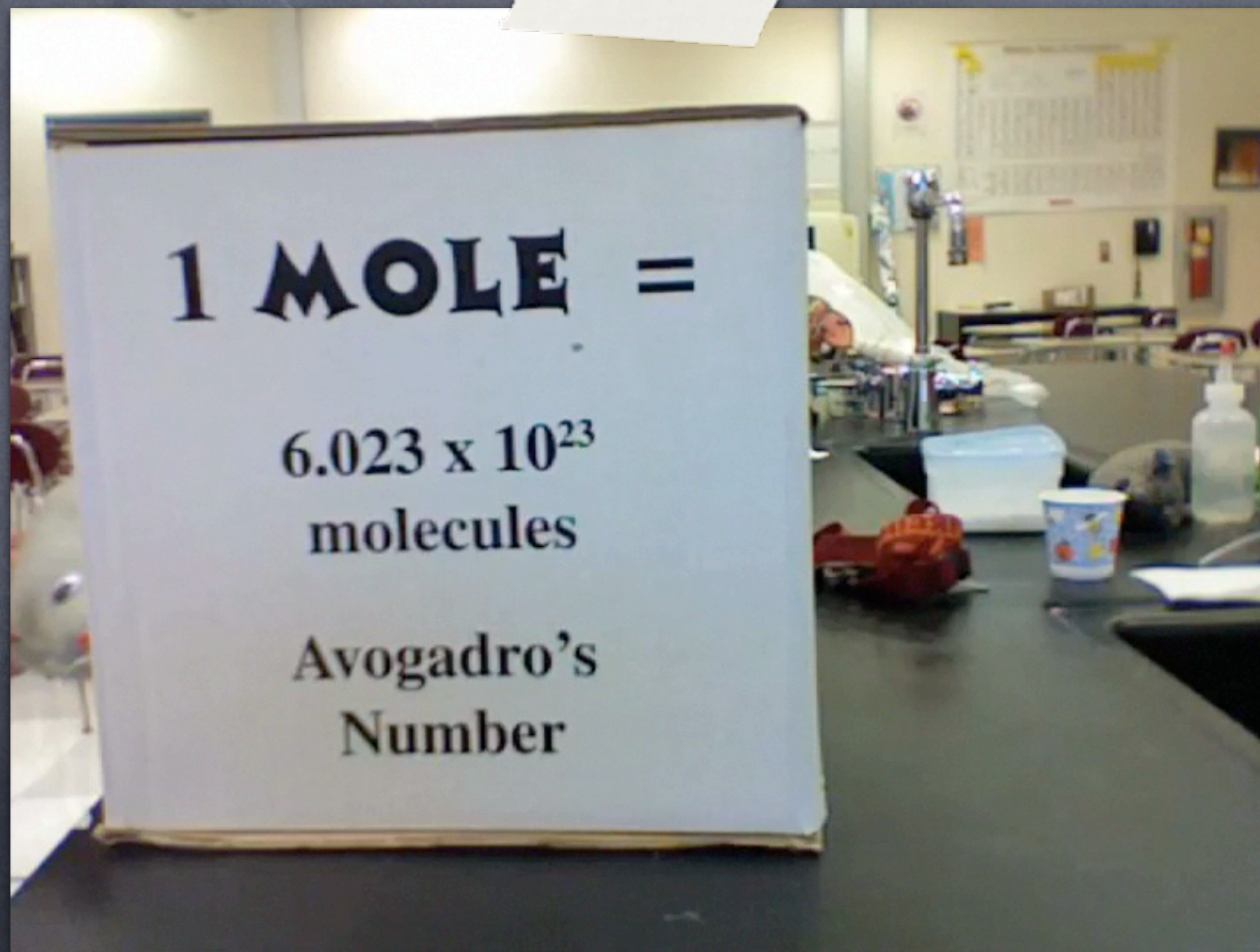


How many atoms are in 2.5 mol  $\text{NO}_2$ ?

How many atoms are in 4.65 mol of  $\text{NO}_2$ ?



# What about moles of gases?





# Molar Volume of a Gas

- 1 mole of any gas = 22.4L at STP
- What is STP? – Standard Temperature and Pressure
- = 0 degrees Celsius and 1 atmosphere pressure
- **REMEMBER, 1 MOLE OF GAS = 22.4 L at STP**



## Practice with molar volume

1 mole of a gas at STP = 22.4 L volume.

To convert moles to volume, use the conversion factor  $\frac{22.4\text{L gas}}{1 \text{ mol gas}}$

a. What is the volume, in L, if 0.6 mol  $\text{SO}_2$  at STP?



What is the volume of these gases at STP?

a. 3.7 mol  $\text{N}_2$

b. 4.65 mol  $\text{N}_2$

c. 0.335 mol  $\text{C}_2\text{H}_6$



## Volume to mole conversions

To go from molar volume to moles, use the conversion factor:  $\frac{1 \text{ mol gas}}{22.4 \text{ L}}$

Find the number of moles of these volumes of gas:

a. 0.2 L  $\text{H}_2$

b. 0.6 L  $\text{CO}_2$

c. 2.5 L  $\text{CH}_4$



## Converting from moles to mass

What is the mass of 3.0 mol NaCl?

Find the molar mass of NaCl first:  $23.0 \text{ g} + 35.5 \text{ g} = 58.5 \text{ g}$

Then convert:

$$3.0 \text{ mol NaCl} \times \frac{58.5 \text{ g}}{1 \text{ mol}} =$$

a. mass of 9.45 mol  $\text{Al}_2\text{O}_3$ :



b. mass of 2.50 mol iron(II) hydroxide:

What is the conversion factor for  
converting grams to moles?

How many moles are in 465g  $\text{SiO}_2$ ?



Thanks to all our moles for teaching us about moles...

